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OCEANUS

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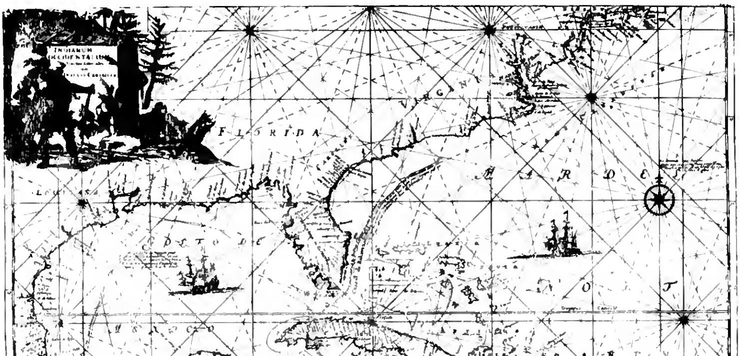
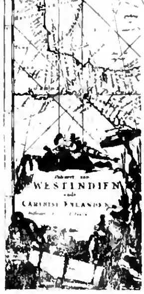




NOVI ORBIS, NOVA DESCRIPTIO.

It is said of Richard Hakluyt, famous chronicler of Elizabethan voyages, that he was drawn to the study of geography upon seeing a map of the world and so 'waded farther and farther in the sweet study of cosmographie.'

Old charts make us think of perilous voyages: 'Of another Nation of wilde men, Of their manners, living and clothing.' They make us think of tropical shores: 'Wheere wee found five Chests, that had beene carefully hidden of the Salvages.' The old charts were used by merchants, sending out their ships: 'With God's mercie,' to bring back spices, tea, flaked cod and rare woods. The mingling smell of those fragrant cargoes still lingers in the warehouses of old ports.

The beauty and craftsmanship displayed in the charts of Mercator, the Blaeus, Dudley, Orelius and others made objects of art of eminently practical works which aided in rapidly expanding the known world and its trade.

Made without the aid of modern surveying methods, before the day of the chronometer, the accuracy of old sea charts is amazing. Indeed, the coastlines of the world were much better known than the land, where, as Jonathan Swift exclaimed in 'On Poetry, A Rhapsody:'

'So geographers, in Afric maps
With savage pictures fill their gaps,
And o'er unhabitable downs
Place elephants for want of towns.'

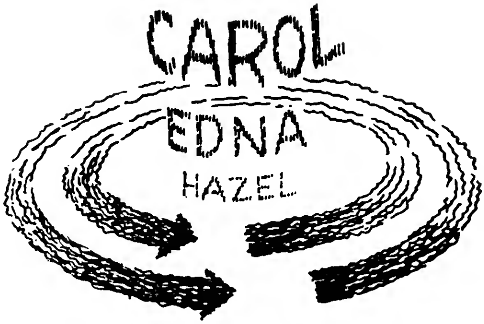
EDITORIAL

We hereby resolve and faithfully promise the readers that we shall never hold out a tidbit of "coming attractions" as we did in the summer issue of OCEANUS.

"We hope to be able to report on a most interesting and fantastic project for which the Institution has prepared the groundwork". Indeed we did. But what happened? As soon as the summer issue was out, the "Texas Towers Project" was on the front pages of all metropolitan newspapers.

Under the guidance of Mr. Iselin and Dr. Zeigler, submarine geologist, the research vessel Caryn had made many topography surveys to decide where the radar warning towers could be placed off the East Coast. Predictions of ocean wave conditions, surface and subsurface currents, etc., had also been made. Messrs. Owen, Zeigler, Athearn and Edwards repeatedly had donned their aqua-lung equipment and exposure suits and during all seasons of the past year went to the bottom in the hazardous currents of Georges Bank off Cape Cod and in other areas. As we go to press some of our divers are on the site of the Georges Bank tower to place an unattended wave recorder on one of the pilings below sea level.

Deep borings made by a DeLong Texas oil barge on Georges Bank provided some interesting geological information. It appears that the Bank is a drowned "Nantucket", a series of underwater sand dunes surrounded by deeper water where the bottom is covered with typically soft sediments. How the sand remains on the Bank is still an unsolved puzzle. In a future issue of OCEANUS we hope to report ....



Carol, Edna and, as we write this, Hazel are not exactly favorite names for girls in this fall's baby crop at Woods Hole. Although Edna merely let us know that she was passing by, Carol hit us with all her might at the time of high water between 10:00 A.M. and 1:30 P.M. on August 31.

As the water rose higher and higher Woods Hole harbor was swept clear of yachts, small and large. Several large yachts were deposited on the lawns of some of our Associates living on Penzance Point, among them the Buccaneer of our Trustee Dr. Detlev W. Bronk. A total loss the ship was burned to the ground a week later, a sad sight indeed for those who love the sea and ships and sadder still if one knows how attached Dr. Bronk was to his beautiful vessel.

The Institution's ships by contrast faired quite well. Fortunately, Atlantis was at Bermuda while the Caryn and the Bear rode out the storm alongside our dock. Only minor damage was suffered by the ships, although it took the combined efforts of Port Captain John Pike, ship's officers and crews to save the ships. First mate James Cavanaugh of the Caryn received a severe blow on the head from which he has recovered. The Asterias was tied safely on the leeside of the town dock.

During the worst of the storm the water level rose waist deep on Main Street, flooding and damaging much equipment in the basement of the Institution building and the main floor of the new Laboratory of Oceanography. A heavy beam battered the dockside walls of the Hydraulics Laboratory and the welding shop but the most serious damage was that done to the docks and seawalls, necessitating extensive and expensive repairs.

The hurricane also caused losses in less tangible things, such as time lost to repairing, the enforced absence of employees and the work loss caused by the discontinuation of electricity and telephone service for almost a week.

As a bright point on the horizon some good may come from the storms. Dr. Redfield and Mr. Miller have collected scientific data regarding the path and the high water levels associated with Carol. It is hoped that these data and similar information gathered by Dr. Redfield after previous hurricanes may aid in predicting the floods associated with hurricanes of any given path.

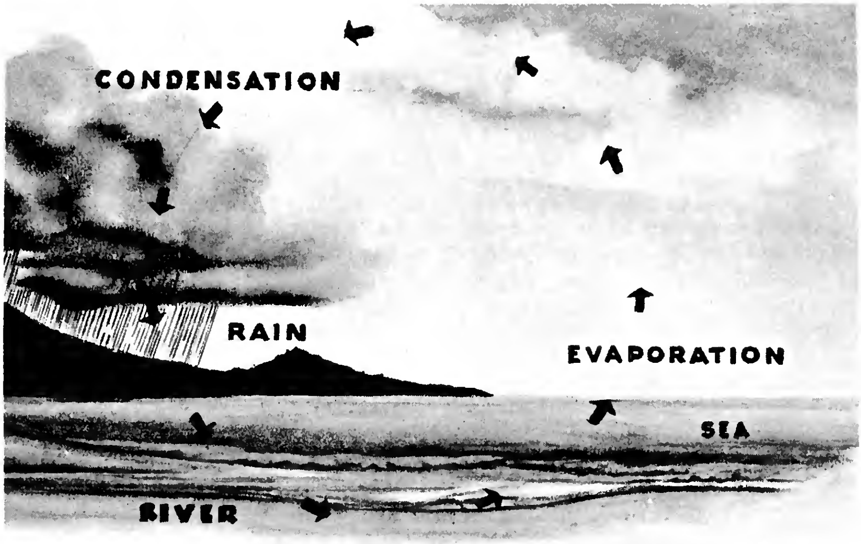


DIAGRAM of WATER CYCLE

TAGGED WATER

by A. C. REDFIELD

THE MOVEMENT OF WATER from the air to the land, from the land to the sea, and from there back to the atmosphere is called the water cycle. It is one of the great processes on which the varied character of man's environment depends. It supplies water for growing crops, energy for electric power, rivers to float ships, and ponds for fish and boys and girls to swim in.

Science is concerned with tracing the movements of water across the face of the earth in its every detail. Much is learned from measuring the quantities of water which move as such, as we do with rain gauges, current meters, hygrometers, and the like. But how can we tell from whence comes the water which falls in a summer thundershower, or what becomes of the water of a melting iceberg, or the outflow of a river into the ocean? When rain falls on land we know quite surely that the water which does not evaporate flows back to the sea. How much evaporates, and what paths does the moisture of the air follow before falling again as rain? And what course does the water which falls in the sea take before passing back into the atmosphere?

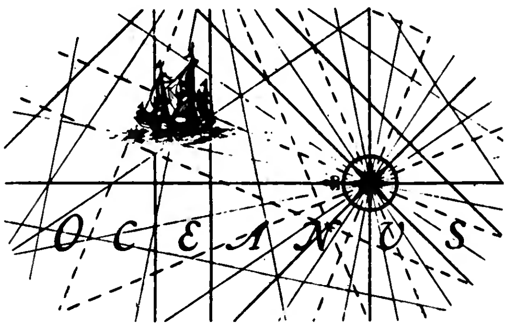
To answer these questions we need to be able to tag the parcels of water or the water molecules themselves so that we may know them when we meet them again.

Meteorologists recognize the source of the great parcels of air which make the weather by their temperature and humidity. Polar air is cold and dry, air masses from over the Gulf of Mexico are warm and moist. In this sense, the air is tagged by its physical properties. In the same way sea water is tagged by its temperature and salinity. These qualities do not change rapidly as the water drifts about. They enable us to trace its movements over great distances and to learn where and to what extent one mass of water is mingling with another. This is one of the reasons oceanographers are so much concerned with measurements of temperature and salinity. Other properties of sea water, such as oxygen or phosphorus content, may also be used as tags, but these markings are not indelible, since they may be altered by the activity of animals and plants.

Atomic physics has given us a new kind of tag -- this time a marked water molecule. About one water molecule in seven thousand is heavier than the others because one hydrogen atom in the H_2O is replaced by an atom of deuterium. Deuterium is an isotope of hydrogen; that is to say, it is an atom which behaves chemically just like hydrogen; but actually it weighs twice as much. Water which contains deuterium is called heavy water, and it can be identified by its weight.

Heavy water does not evaporate as readily as H_2O. For this reason the evaporate from natural bodies of water, the moisture which passes into the atmosphere, is lighter than the water from which it came. Its deuterium content is about 6 per cent less than the natural water. It follows that the deuterium content of the water of the ocean will increase where evaporation is heavy. Its content in the atmospheric water will vary depending on what part of the ocean the water vapor has come _from_. So it is that sea water and air become tagged by their deuterium content. When rain falls on the land its deuterium should help tell where it came from, and as it flows down a river how much has been "lost" by evaporation.

The discovery of heavy water and the development of techniques for its measurement have given oceanographers and meteorologists a new tag for water, and a new problem to puzzle out. The U.S. Geological Survey has started a study of the distribution of deuterium in natural waters. The Woods Hole Oceanographic Institution is cooperating in this investigation by supplying samples of water from strategic places and by advice on the oceanography of the problem. The ocean is the great source of the waters of the earth. The distribution of deuterium in the ocean will be the starting point from which the migrations of heavy water through the air and across the land will be traced.



ASSOCIATES NEWS

The Executive Committee of the Institution has voted to use $5,000 from the Associates Fund to support basic research. It will be used to advance the program reported on pages 3-5 of this issue.

Funds from the Associates already have been applied to institute an annual summer program of lectures for the benefit of our staff members, students and others. Last summer, Dr. Jule G. Charney of the Institute for Advanced Study gave a series of six lectures on modern developments in meteorology. Other worthy programs of great benefit to the advancement of our basic knowledge of the sea are in preparation and will be discussed with your Executive Committee.

Meritt-Chapman and Scott Corporation of New York has joined the growing Corporate Associates group.

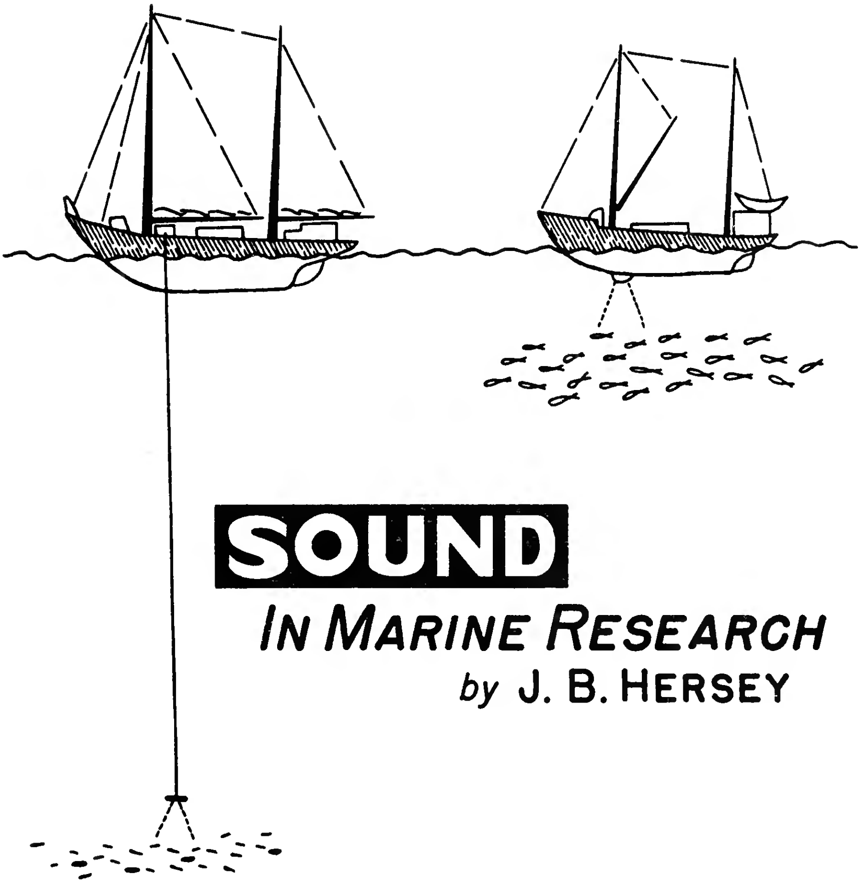
SEPTEMBER WAS a traveling month for our Director and several staff members. Admiral Smith flew to Rome, Italy to attend meetings of the International Geophysical Union and to take part in planning the oceanographic observations to be made during the Geophysical Year 1957-58. During that year 28 countries are co-operating in making simultaneous observations which will give us a better understanding of our physical world.

Dr. Mary Sears and Mr. Wm. S. von Arx also were in Rome. Dr. Sears attended discussions of the Committee on Oceanography and Mr. von Arx read a paper at the meeting.

Following the Rome meetings, Admiral Smith visited oceanographic and meteorological facilities in Germany, Norway, Sweden and England. Dr. Sears and Mr. von Arx also went to foreign laboratories.

Mr. Harry J. Turner read a paper on shellfish at the Paris, France meetings of the International Council for the Exploration of the Sea.

Mr. Alfred H. Woodcock, Duncan Blanchard and Theodore Spencer are in Hawaii taking part in an international study of natural rainfall for which Hawaii makes a perfect nature-made laboratory. Mr. Woodcock laid the groundwork for the present large scale undertaking during a previous visit of about nine months.



SOUND IN MARINE RESEARCH

by J. B. HERSEY

MANY AMERICANS INTERESTED IN THE OCEANS and their effect on human life persistently associate scientific techniques used in oceanography with their immediate, practical application in human affairs. Thus, biological investigations are associated strongly with fisheries, submarine geophysics with oil exploration and underwater acoustics with the art of war. The necessary restriction of public knowledge about many of the details of the naval sciences has all too frequently left the impression that underwater acoustics is a discipline of limited scope and application and, further, that it is never to be inquired about because of its military classification.

This impression is partially correct in that underwater sound is being applied to naval problems in ways and on a scale that is not to be publicly discussed. However, the scope of its possible usefulness in studying the oceans is far from limited to naval science. For example, sonic sounding methods have been widely used since shortly after the first World War and more recently similar techniques

have been very widely used for finding commercially important fishes; sound transmission in the sea is used everyday in offshore oil exploration, and in scientific study of the structure of the Earth's crust beneath the oceans. I believe that these techniques and others in underwater acoustics are promising aids in the general scientific study of the oceans and that more of them will come into everyday use in the future. There are several of us with this belief working in underwater acoustics at the Institution, and are devoting some of our time to non-military studies to increase our own understanding of underwater sound phenomena and to apply its techniques to other marine science problems. We have shared some of our enthusiasms with the Woods Hole Associates both during the past two annual cruises and during your visits to the Institution over a longer time. In this article I am going to sketch for you the progress of the past few years in one application of underwater acoustics. If you are sufficiently interested we would be glad to tell you about other parts of our scientific program in future issues of OCEANUS.

Sonic sounding

The first underwater acoustic technique to be applied in the everyday life of the sea is sonic sounding. This technique finds the depth of water below a ship by measuring the time required for a burst of sound generated at the ship to echo from the bottom and return to the ship. While this may seem somewhat "old hat" because we have all heard about it many times before, nevertheless it is a basic technique which has many intriguing variations that can be applied to problems far removed from the capabilities of present day instruments. One such variation is its use as a "fish-finder" in commercial fishing. The scientific application I want to tell you about parallels this application rather closely.

The early echo sounders employed a rather low-pitched burst of sound and because ships characteristically are very noisy in the low frequencies it was necessary to stop the ship whenever a sounding was taken. Several years before the second World War sounding machines were developed employing very high frequencies, usually above the range of human hearing. Not only are ships quieter at the high frequencies but it turns out to be feasible to design a sound source and receiver for these high frequencies that is so strongly directional that it is largely "deaf" to the noise of the ship but hears the echo from the bottom with great

efficiency. These new instruments allowed a ship to take soundings continuously while underway. This possibility in turn made it profitable to record the soundings automatically with specially designed recorders. These are the familiar recorders of every commercial echo sounder in which a recording stylus moves across a long strip of recording paper at a speed gauged to the speed of sound in water to record the outgoing burst of sound near one edge of the paper and the bottom echo at its appropriate depth on a printed scale. Thus the bottom could readily be recognized by its consistent recording on several successive soundings. Such a record is shown in fig. 1. It represents a twenty-four hour recording taken on the ATLANTIS in deep water off the southern coast of New England in 1947.

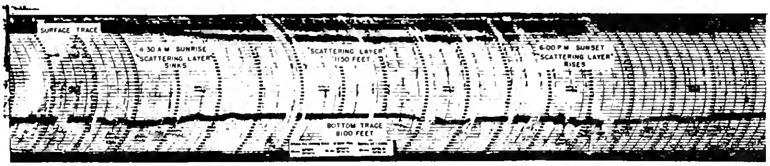


FIG. 1

Scattering layers

As soon as these instruments were used observers found that on occasion echoes appeared to make consistent recordings which could not have come from the bottom. These extraneous echoes were of various forms and not all of them have been satisfactorily described. The most persistent in deep water was an apparent layering within the water itself. This was studied in some detail by California scientists during the second World War who called a layering they consistently observed the "Deep Scattering Layer". Since then a similar layering has been observed in all but the two polar oceans. Martin Johnson in the early California work reasoned that the cause of the layer was related to animal life in the sea because the commonly observed layer migrated upward at sunset and downward at dawn. Fig. 1 shows a typical scattering layer in the Atlantic performing such a diurnal migration. The early California work was all done prior to 1946. Since that time there has been considerable speculation about the "cause" of the scattering layer. <u>What is it</u>? Today this question still lacks a satisfactory answer. Nevertheless this puzzle is much nearer solution as a result of subsequent experiments all of which are basically similar to the ordinary echo sounder.

Firstly you will see that in fig. 1 an ocean depth greater than a mile is portrayed on a piece of paper a few inches wide (the original recording is 8 inches wide). Furthermore, the burst of sound has a length equivalent to a depth of a tenth of a mile, or a hundred fathoms. This amounts to painting with a rather broad brush! When one "looks" at the ocean with a much shorter sound signal and with a much more open depth scale a very different picture is frequently seen, as in fig. 2.

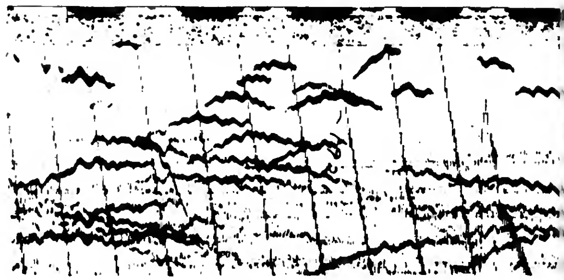
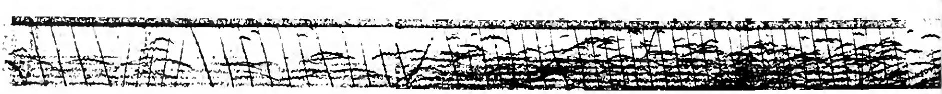


FIG. 2

This is a record taken of a scattering layer with a sound signal about 5 feet long whose full scale depth is 210 feet. The "layer" now appears as isolated individuals whose repeated echoes form crescent shaped patterns as they drift beneath the echo sounder. Each crescent may be caused by an individual or a group moving together. They appear as a layer with the recorder of fig. 1 because they are concentrated in a certain depth range and because the long sound signal tends to average out their individuality, recording them only as a group. The technique illustrated in fig. 2 proves that the scattering layer of that recording is not a single extensive reflecting surface. It is made up of individuals or small groups which inhabit a restricted depth range. When a long sound signal is reflected from them and received by a ship moving relatively rapidly over them the resulting record looks like a continuous layer.

Now what happens when a layer "migrates"? Do the individuals of a layer all swim upwards at sunset or do they concentrate both from above and below at shallower and shallower depths as the light intensity decreases? This question was studied recently from the ATLANTIS by suspending an echo sounder just above a layer before sunset. Fig. 3 shows what happened. Shortly after sunset the concentration of crescent shaped echo sequences increases, and further, the crescents now move consistently upward from left to right. In due course a very dense concentration of these individuals moves upward across the record, while

sunset



later on the concentration decreases and marked upward migration ceases. The time of the upward motion of the individuals agrees with that of the layer recorded by the former technique, thus we know that the upward motion of the layer is made up of upward moving individuals. To know that individuals or small groups of them are indeed the sound scatterers is a very considerable help along the way to identifying them.

Underwater photography

As a next observation, which we are trying hard to make now, we are combining the acoustical apparatus that made the records of fig. 2 and 3 with an underwater camera. With such a combination we hope to take photographs of whatever is reflecting the sound only when we know it must appear in focus to the camera. This has proven to be a difficult experiment to do the first time, but we hope to do it this fall. Although many hundreds of photographs have been taken to study the deep scattering layer, all have been relatively unrewarding. For example, while a few people have photographed individuals in good enough focus for identification, we could not demonstrate that the camera was ever focussed on a known sound scatterer. In this experiment we can be certain it is focussed on one and, further, we can know how strong a scatterer it is. The remaining uncertainty is whether the photograph will permit us to identify the scatterer. Other photographs in the deep scattering layers have shown images, but, with the few exceptions they were too indistinct to be identified at all. Thus the first successful photographs are an exciting prospect. If we are fortunate we may know at least one kind of creature making up the scattering layer and may have a useful technique for discovering more. If we are not -- well, I'll not borrow trouble, but let events speak for themselves.

While this technique has been developing we have worked on other acoustic means of describing the sound scatterers, and have learned other useful methods which will also aid in identifying small sound scatterers such as fish. These identification methods can often be used where a direct means such as photography is impractical. However, this is another story.

FIG. 3

CURRENTS & TIDES

For once the Atlantis is looking for bad weather rather than hoping to avoid it.

Testing of newly developed wave recorders makes it necessary to find waves 8 to 16 feet high. Two Navy planes are working with the ship to obtain stereoscopic photographs of ocean waves for the Stereo Ocean Wave Project sponsored by the Office of Naval Research.

In his hotel at Rome, Italy, Admiral Smith accidentally met Associates Mr. & Mrs. Thomas H. Wickenden. Mr. Wickenden is Vice-President of International Nickel Corporation.

Mr. C.O'D. Iselin, Dr. A.C. Redfield and Dr. M. Ewing attended a *Conference on Oceanography* sponsored by the Department of Mines and the Nova Scotia Research Foundation held at the Nova Scotia Centre for Geological Sciences.

The November issue of the 'UNESCO'' Courier contains a four page article on oceanography.

Plans are underway for a two months winter cruise to the Carribean Sea. The structure of the Island Arc, its geological formation and history will be studied with the aid of seismic measurements, coring tubes, rock dredges, etc.

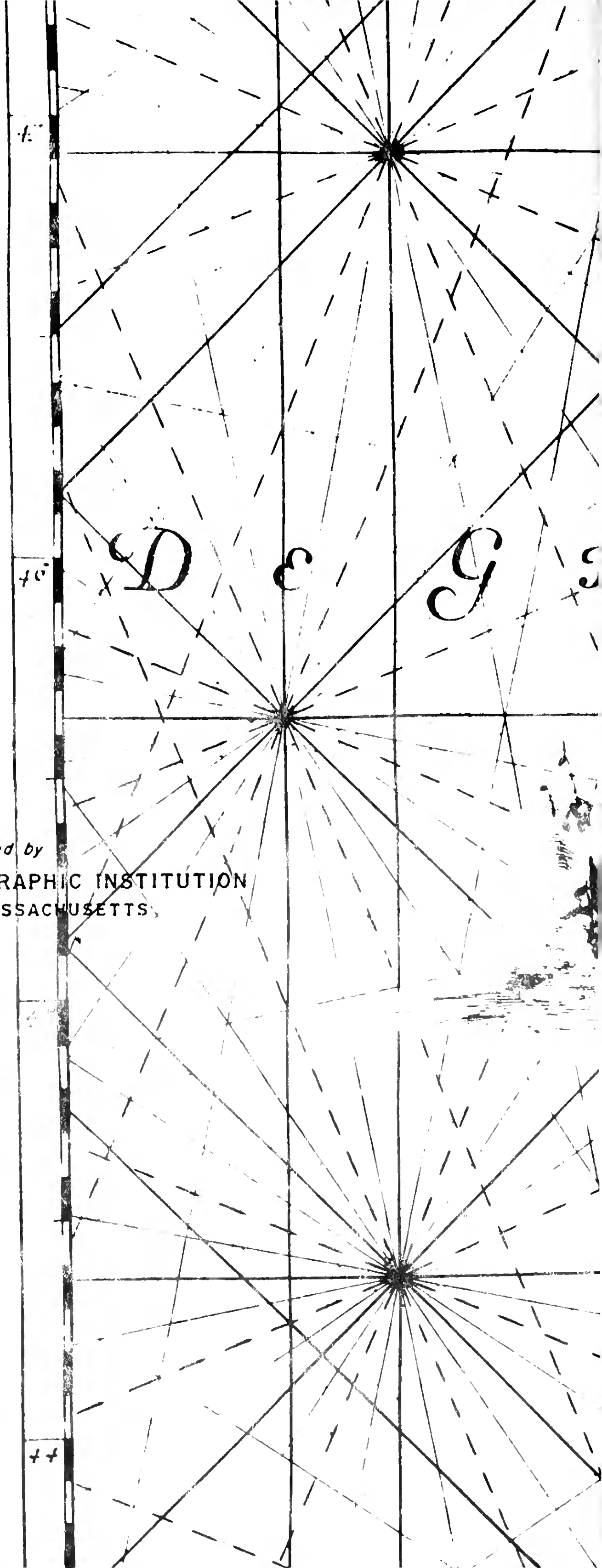
The research vessels Atlantis and Bear will participate in the cruise. Dr. Charles B. Officer, Jr. is to be chief scientist.

Following this cruise the vessels will be taken over in a Carribean port by Dr. J.B. Hersey who will study the structure of the Blake Plateau and the deep water area to the southeast of the Carolinas.

A white sided porpoise was harpooned on Georges Bank recently by Wm. J. Shields, engineer of the R.V. Bear.

Cetologist Wm. E. Schevill and biologist Richard H. Backus dissected the small whale about whose biology very little is known.

A small relative of Moby Dick, an albino, was also noticed among the school of white sided porpoises.



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